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Environmental Technology Verification Quality Assurance Project Plan

Emissions of VOCs and Aldehydes from Commercial Furniture

Prepared by

Research Triangle Institute

Under a Cooperative Agreement with

U.S. Environmental Protection Agency

ETV ETV ETV

Notice

This document has been subjected to the U.S. Environmental Protection Agency's quality assurance and administrative reviews and has been approved for publication.

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Emissions of VOCs and Aldehydes from Commercial Furniture

Prepared by

Research Triangle Institute
Research Triangle Park, NC

EPA Cooperative Agreement No. CR 822870-01

Project Officer: Leslie E. Sparks
National Risk Management Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC

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EPA

Dr. Les Sparks
Dr. Nancy Adams

Research Triangle Institute

Dr. David Ensor
Ms. Deborah Franke
Mr. Don Whitaker
Dr. C. E. Tatsch

List of Acronyms/Abbreviations

ACR	Air Change Rate
ANSI	American National Standards Institute
DQO	Data Quality Objective
EPA	Environmental Protection Agency
ETV	Environmental Technology Verification
ISO	International Standards Organization
QA	Quality Assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
RTI	Research Triangle Institute
SOP	standard operating procedure
Protocol	Large Chamber Test Protocol For Measuring Emissions of VOCs And Aldehydes
VOC	Volatile Organic Compound

List of References

RTI, *ETV Large Chamber Test Protocol for Measuring Emissions of VOCs and Aldehydes*, Research Triangle Institute, Research Triangle Park, NC, August 1999. Available at http://etv.rti.org.

RTI, *Quality Manual, Version 1.0*, Research Triangle Institute Environmental Sciences and Engineering, October 1997.

U.S. EPA, *Environmental Technology Verification Program Quality and Management Plan for the Pilot Period (1995-2000),* EPA Report No: EPA/600/R-98/064, National Risk Management Research Laboratory National Exposure Research Laboratory Office of Research and Development U.S. Environmental Protection Agency Cincinnati, Ohio 45268, May 1998. Available at http://www.epa.gov/etv/.

SECTION A: PROJECT MANAGEMENT

A4: Project/Task Organization

The US Environmental Protection Agency (EPA) has overall responsibility for the Environmental Technology Verification (ETV) Program for Indoor Air Products. Under a cooperative agreement with EPA, Research Triangle Institute (RTI) will perform the testing, evaluate the data, and prepare the project deliverables, including the verification report and the verification statement. The various quality assurance (QA) and management responsibilities are divided between EPA and RTI key project personnel as defined below. The lines of authority between key personnel for this project are shown on the project organization chart in Figure 1.

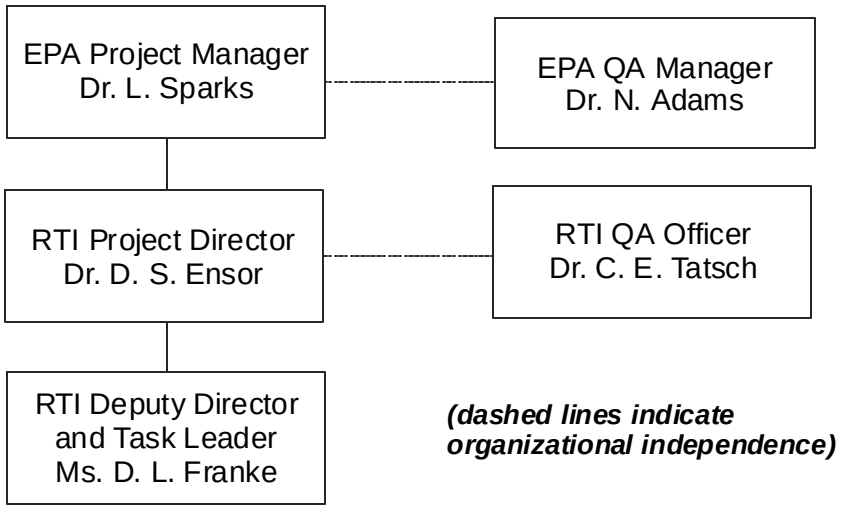

Figure 1 Organizational Chart

A4.1 Management Responsibilities

Project management responsibilities are divided among the EPA personnel and RTI personnel as listed below.

A4.1.1 EPA Project Manager

The EPA Project Manager, Dr. Les Sparks, has overall responsibility for the program. He is responsible for granting final approval of project plans and reports and seeing that plans are implemented according to schedule, and he has the authority to commit the resources necessary to meet project objectives and requirements.

A4.1.2 RTI Project Director

The RTI Project Director, Dr. David Ensor, and RTI Deputy Director, Ms. Deborah Franke, are responsible for task implementation and technical quality control. The RTI Program Director is also responsible for the following tasks:

- Define objectives
- Develop a detailed work plan schedule,
- Review work progress to ensure that budgets and schedules are met,
- Prepare quarterly progress reports,
- Update and distribute revisions of the Quality Assurance Project Plan (QAPP) as necessary, and
- Oversee preparation of verification reports and verification statements.

Ms. Franke will also serve as Task Leader for this program and will be responsible for coordinating with the participating laboratories.

A4.2 Quality Assurance Responsibilities

QA responsibilities are divided among the EPA personnel and RTI personnel as listed below.

A4.2.1 EPA Quality Assurance Manager

The EPA QA Manager, Dr. Nancy Adams, will conduct audits of RTI's QA System and of specific technical activities on the project. She will be available to resolve any QA issues relating to performance to EPA's QA requirements. Specific functions and duties of the EPA QA Officer include approving the contents of this QAPP and subsequent revisions and reviewing QA reports prepared by RTI, including QA evaluations and audits.

A4.2.2 RTI Quality Assurance Officer

The RTI Quality Assurance Officer (QAO), Dr. C. E. Tatsch, is responsible for ensuring that QA/QC procedures described in this QAPP are followed. In addition, the RTI QAO will:

- Maintain regular communication with the EPA QAO regarding QA issues,
- Report on the adequacy, status, and effectiveness of the QA program on a regular basis to the Task Manager,
- Conduct audits of lab activities as necessary and prepare audit reports and
- Ensure that corrective action, if necessary, is properly implemented and documented.

A5: Background Information

The testing is for measurement of emissions of aldehydes and volatile organic compounds (VOCs) from office furniture under conditions designed to approximately simulate product use in the commercial office environment. Formaldehyde and total volatile organic compounds (TVOC) can be measured in

addition to a range of other aldehydes and individual VOCs. Emissions levels are determined by placing the furniture into a large environmental test chamber under specified test conditions then measuring chamber air concentrations of aldehydes and VOCs at selected time intervals. Product-specific emission factors are calculated from the chamber air measurements. The method provides a standard test to reproducibly and accurately measure emissions from office furniture under controlled laboratory conditions.

The method uses a large environmental test chamber (20-35m^3) to evaluate VOC and aldehyde emissions from office furniture over a specified time period. Considerations within the method and the accompanying appendices include: product acquisition and packaging to preserve the integrity of the product with respect to organic emissions; product preparation for the emissions test that mimics operations in the office environment; construction and performance characteristics of the environmental test chamber; air flow through and air circulation within the test chamber; and implementation of the analytical methodology. For additional details, refer to the Protocol.

A6: Task Description

The task consists of three steps. The first step is to identify and acquire furniture qualified for verification under the test protocol. The next step is to actually perform the testing. The final step is to complete the verification report and verification statement and submit them to the Environmental Protection Agency.

For a list of critical and non-critical measurements, refer to Table 1, which corresponds to Table C-1 of the Protocol. A successful test shall be one that meets these objectives.

Various logging requirements shall be implemented for all test parameters including chamber and analytical performance. Many of these are identified in ASTM D5116-90. Additionally, personnel conducting each procedure should be so noted. Records of the devices used, date and time of tests, and the test results should be part of the QA/QC recording process. The completeness of records indicates the care and attention given the quality control process.

A7: Data Quality Objectives and Criteria for Measurement Data

Data Quality Objectives (DQOs) are qualitative and quantitative statements designed to ensure that the type, quality, and quantity of data used are appropriate for the intended application. The DQOs for this project are listed and described in Table 1. These parameters are: temperature, relative humidity, air flow rate, furniture unit quantity, and chamber air concentrations.

The overall ETV project goals are to

- To verify the environmental performance characteristics of commercial-ready technology through the evaluation of objective and quality assured data.
- To provide potential purchasers and permitters with an independent and credible assessment of what they are buying and permitting.

A successful test will be defined as a test where the measured parameters fall within the quality control limits summarized in Table 1 of this document.

A7.1 Temperature

Temperature in the chamber must be monitored continuously. A measurement device that can meet the specifications given in Table 1 must be used.

A7.2 Relative Humidity

Relative humidity in the chamber must be monitored continuously. A measurement device that can meet the specifications given in Table 1 must be used.

A7.3 Air Flow Rate

Air flow rate must, at a minimum, be monitored immediately before the product is placed in the chamber (at the same time background contamination checks are made) and each time chamber air samples are collected. The air exchange, ACH (h^{-1}), is calculated from the air flow rate as air flow (m^3/h) divided by chamber volume (m^3). The accuracy of this air exchange rate must be confirmed (within 5% accuracy) using procedures similar to that presented in ASTM Method E741 for tracer gas application. Alternatively, ASTM Method E741 may be used as the primary method for determining air exchange rate. A measurement device that can meet the specifications given in Table 1 must be used.

A7.4 Furniture Unit Quantity

Furniture Unit Quantity to be tested must be determined for each test. This is done simply by having the operator count the number of units. In addition, the total surface area of the furniture, as provided by the manufacturer, should be noted when available.

A7.5 Chamber Air Concentrations

Concentration of aldehydes and VOCs in the chamber must be monitored according to the protocol. Measurement devices and analytical equipment that meet the requirements in the protocol and the specifications given in Table 1 must be used.

A7.6 Comparability

All tests will be performed following the same test data collection techniques, measurement procedures, and methods. Therefore, all the results will be comparable.

Table 1 Data Quality Indicator Goals

Parameter	Precision	Accuracy	Completeness[a]
Temperature	±2.0°C	±0.5°C[c]	>90%
Relative Humidity	±5.0% RH	±5.0% RH[c]	>90%
Air Flow Rate	±10.0%	±10.0%[b]	>90%
Chamber Air Concentration			
- Aldehydes	±40% RSD[d]	±30%[e]	>90%
-VOCs	±40%RSD[d]	±30%[e]	>90%

[a] Completeness characterizes the percentage of the planned measurements that are actually conducted.
[b] Accuracy certifications should be supplied by the manufacturers of the sensors who calibrate them against NIST-traceable primary sources. Precision measurements are obtained within the laboratory by continuous recording of the parameters. Non-compliance requires immediate correction and/or replacement of sensors. Calibrated replacements shall be kept in the laboratory. Experience indicates that routine calibration and tracking of precision prevents non-compliance.
[c] Emission factors will be determined by unit (using object quantity) and by surface area. The surface areas will be provided by the manufacturers.
[d] RSD = Relative standard deviation for replicate chamber air samples
[e] Based on recovery from laboratory controls

A7.7 Representativeness

As described in the Protocol, Appendix A, Product Handling, the furniture will be ordered through a local distributor, using the normal procedures. The furniture will be taken directly from the production line and should be representative of the furniture being produced.

A8: Special Training Requirements/Certification

The ETV program is open to multiple test lab participation. All participating labs must verify that their environmental test chamber perform according to the requirements of the program and accept on-site audits by EPA and/or RTI personnel.

Test lab qualifications include:

- Possess the equipment and facilities required to perform emissions tests per the " protocol." This will require the use of sophisticated analytical instrumentation and equipment. Proper use of the method requires experience in environmental chamber operation, sorbent system use, and GC/MS analysis for identification and quantitation (or semi-quantitation) of organic species. Details for chamber requirements are found in Appendix B of the Protocol.
- Be an independent organization (e.g., not be a manufacturer's in-house lab).
- Be registered as ISO 9000 (or ISO 25) compliant or meet ANSI E4 specification and guidelines for Quality Systems for Environmental Data collection and Environmental Technology Programs.
- Allow on-site audit by EPA and/or their representatives.
- Prepare a Quality Assurance Project Plan (QAPP).

The protocol chosen for analysis of furniture emissions in the laboratory is restricted to use by, or under the supervision of, personnel experienced in the use of GC and other analytical equipment and skilled in the interpretation of raw data. Each person must demonstrate his or her ability to generate acceptable results with this method.

A9: Documentation and Records

This section identifies the documents and reports to be generated as part of the verification program and the information to be included in the verification reports and verification statements. A description of the data management system established for this task is presented in Section B10.

A9.1 Laboratory Documentation

Test data and notes are recorded in laboratory notebooks. Test personnel shall record:

- Testing date and location
- Manufacturer and model number
- Physical description of furniture
- Number of units of furniture
- QC checks
- Other site specific data that is not otherwise recorded.

A9.2 QA Reports

As described in Section C1, EPA personnel or designated representatives may audit the test laboratory at the discretion of EPA. The auditors will prepare an audit report summarizing the observations and findings of those audits. As needed, the audit reports will be supplemented by a Corrective Action Request to document changes required to meet established quality objectives.

A9.3 Reporting

The report will consist of calculated and reported data. Raw data should be included as an appendix. The contents of the test reports are described in detail in Section 11 (Table 4) of the Protocol. At a minimum each report will include:

- Executive Summary
- Testing Laboratory Identification.
- Test Objectives
- Facilities and Equipment
- Experimental Design
- Sample Description
- Experimental Procedures
- Data Analysis
- Results
- Discussion and Conclusion
- Quality Assurance/Quality Control.

SECTION B: SAMPLING PROCESS DESIGN

B1: Sampling Process Design

Aldehydes in chamber air samples are collected on silica gel cartridges coated with 2,4-dinitrophenylhydrazine (DNPH). The DNPH-aldehyde derivatives on the cartridges are eluted with acetonitrile, then analyzed by high performance liquid chromatography (HPLC) with ultraviolet (UV) detection. General procedures are outlined in EPA Method TO-11 and EPA Method IP-6A. While the test protocol specifies aldehydes, the buyer, seller and laboratory may agree to only provide formaldehyde information.

VOCs in chamber air samples are collected on sorbent cartridges (tubes). VOCs trapped on the cartridges are thermally desorbed then analyzed by gas chromatography/mass spectrometry (GC/MS). Results of these analyses are used to estimate both individual and total volatile organic compound (TVOC) concentrations in chamber air samples. While the test protocol specifies speciated VOCs, the buyer, seller and laboratory may agree to only provide TVOC information. General procedures for the use of sorbent cartridges are outlined in EPA Methods TO-1 and TO-17.

B2: Sampling Methods Requirements

Sampling method requirements are specified in Section 8 of the Protocol. Requirements are detailed for the following:

- Aldehyde Sampling
- VOC Sampling
- Test Chamber Design and Conditions

Critical specifications of the test chamber are found in Appendix B of the Protocol.

B3: Sample Handling and Custody Requirements

The furniture acquisition, packaging and shipping will be performed in accordance with Appendix A of the Protocol.

B4: Analytical Methods Requirements

The analytical methods required are described in Section 8 of the Protocol.

B5: Quality Control Requirements

The quality control requirements are detailed in the Protocol. Section 2.0 of Appendix C addresses Quality Assurance and Quality Control. Acceptance criteria are listed in Table C-2.

B6: Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Qualification tests will be conducted as part of each test run, as required for the specific instrumentation, or after a change that may alter performance as described in the Protocol.

B7: Instrument Calibration and Frequency

All major components of the test shall be audited at least once, by the QA Officer. These may include but not be limited to the preparation of samples, laboratory systems, analytical measurement systems, data entry, and processing. Calibration will be performed in accordance with manufacturer's recommendations; at the least, calibrations will be performed annually.

B8: Inspection/Acceptance Requirements for Supplies and Consumables

Inspection and acceptance requirements for suppliers and consumables will follow standard RTI practices, as defined by

B9: Data Acquisition Requirements (Non-direct measurements)

No types of data are needed for project implementation or decision making that would be obtained from non-measurement sources such as computer databases, programs, literature files, or historical databases.

B10: Data Management

Data management may vary between labs. However, procedures for labeling and tracking product samples, as well as chamber air samples shall be described in the individual QAPP and must identify the activities and processes planned for documenting the traceability of the conclusions and information in the verification report. Chain of custody documents shall be used to document all product and sample transfers and operations. A sample custodian shall be designated.

B10.1 Data Recording

Various logging requirements shall be implemented for all test parameters including chamber and analytical performance. Many of these are identified in ASTM D5116-90. Additionally, personnel conducting each procedure should be so noted. Records of the devices used, date and time of tests, and the test results should be part of the QA/QC recording process.

Data for this task will be collected by computer and by handwritten entries. Observations and records such as sample description and collection information will be recorded manually in lab notebooks kept exclusively for this task. Output data generated by some instruments will be fed directly into a computer file and stored as a spreadsheet; printed output will be taped into the lab notebook. Output from other instrumentation shall be recorded as appropriate to the situation.

10.2 Data Quality Assurance Checks

Quality control charts will allow visual analysis of system performance and observation of anomalistic or unacceptable deviations. This may be done by use of the Shewart Chart (reference: Shewart, W.A., 1931, Economic Control of Quality of Manufactured Products, Bell Telephone Laboratories). (Cf. "Manual on Presentation of Data and Control Chart Analysis," 6th ed., prepared by Committee E-11 on Quality and Statistics, ASTM, 1991.)

The need for corrective action may be identified through reviews, internal QC checks, audits or observations made during routine sampling and analysis activities by project staff. All corrective actions will be documented. No further work may be performed until the problem has been satisfactorily resolved, and the QA Officer has acknowledged approval.

QA checks of data as early as possible are essential to provide early warning of potential problems. Several levels of QA checks are specified in the Protocol.

B10.3 Data Analysis

Data analysis will be performed as appropriate to the individual lab, but shall include those calculation required in the Protocol. The emissions factor calculations are described in Section 9 of the Protocol.

B10.4 Data Storage and Retrieval

Laboratory notebooks containing manually recorded information and data output generated from instrumentation will be stored in the custody of the Task Leader for the duration of the project.

Spreadsheet files including raw and calculated data will be stored on computers. The files will be downloaded to a network server backed up nightly on magnetic tape.

Following policy at RTI, project files will be archived offsite at a secure facility for a minimum of five years following delivery of the verification report. The records will not be destroyed without written approval from EPA.

SECTION C: ASSESSMENT/OVERSIGHT

C1: Assessments and Response Actions

Technical personnel working on each task will have the direct responsibility for ensuring that the QA plan is implemented, that the operating parameters are within acceptable limits, and that corrective actions are taken when appropriate. Corrective action will be taken whenever measurement accuracy or bias is outside the limits of objectives for the critical measurements.

Corrective actions include:

- Problem identification;
- Attempting to find the cause;
- Attempting immediate repairs (if possible);
- Reporting or documenting the problem;
- Planning for corrective action (if major repairs are needed);
- Checking that problem was corrected;
- Documenting the corrective actions taken; and
- Recommending changes to instruments, Standard Operating Procedures (SOPs), etc. to avoid similar future occurrences.

The QAO and the Task Leader will be jointly responsible for proper documentation of Corrective Actions. Minor corrective actions are to be recorded in the laboratory notebooks. Major problems will be addressed as outlined above. All corrective actions will be noted in the test report. Depending on the time and expense involved with necessary corrective actions, it will be necessary to consult the Program Manager or the sponsor before implementing any changes in the planned activities.

The RTI ESE Quality Manual and the EPA ETV Program Quality and Management Plan provide information on the types and frequencies of internal audits that are required.

C2: Reports to Management

Audit reports will be sent to all those on the distribution list for the QAPP. Audit reports will be included as appendices to the verification report. Project leaders shall be responsible for generating all status reports. Distribution shall include those listed in Section A3.

SECTION D: DATA VALIDATION AND USABILITY

D1: Data Review, Validation, and Verification Requirements

The major calculations required to determine emission rates are presented in the Protocol. Additional calculations may be required depending on the analytical equipment. These will be specified by the manufacturers and individual tests labs as appropriate in the individual QAPPS.

An acceptable test will be considered one that meets the DQOs per Table 1 and the QC acceptance requirements of Table C-2 of the Protocol.

D2: Validation and Verification Methods

Each verification report will be reviewed by the RTI QAO for compliance with the applicable method and for the quality of the data reported. Data will be reviewed by the RTI Project Leader, after approval by the QAO.

The RTI QAO or other quality assurance person will check for the following:

- Data completeness
- Blanks
- Initial and continuing calibrations
- QC reference and internal standards.

Because the number of samples is extremely small, all calculations will be checked.

D3: Reconciliation with User Requirements

Each ETV verification statement will summarize testing conditions and will state test results. Each ETV test report will present all critical measurements.

The data quality objectives are specified in Table 1. If the DQOs are not met, then the test results will not be considered valid and tests will be repeated after appropriate corrective actions are taken. Data not meeting the specified criteria will not be used in emissions evaluation.